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(54) Solder particle deposition.

(55) Solder particles 220 are deposited onto metallised contacts of a direct chip attach (DCA) site located on a substrate 301. The contacts 302 are coated with a layer of flux 303. A pickup head 211 is positioned in a reservoir 201 of solder particles 220 and particles are attracted to the apertures in the end 213 of the head. The apertures have an arrangement corresponding to the footprint of the metallised

contacts on the substrate. The head 211 is then positioned adjacent the substrate 301 and the particles 220 released. The particles 220 stick to the flux 303 coated on the contacts 302. The particles are reflowed, levelled and again coated with flux. An integrated circuit chip is then placed on the levelled reliefs 501 and the reliefs reflowed again to attach the chip onto the contacts 302.

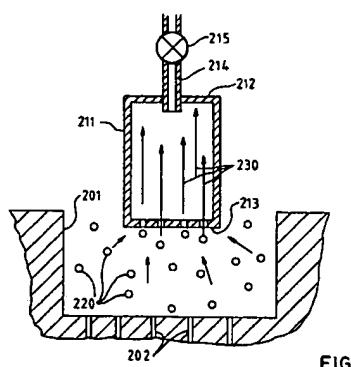


FIG. 2

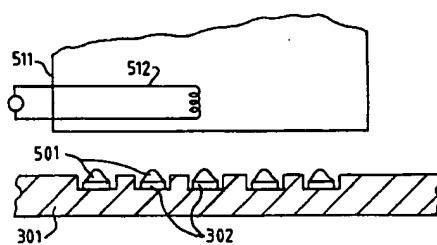


FIG. 5

Field of the Invention

This invention relates to attachment of integrated circuits to substrates in electronic equipment and more particularly to attachment of direct chip attach (DCA) integrated circuits (or chips) to printed circuit boards using solid solder particles.

Background of the Invention

Presently, DCA chips are bonded to metallised contacts (DCA sites) arranged on substrates such as printed circuit boards (PCB's) by applying molten solder particles to a substrate, flattening the particles, applying sticky flux to the substrate, placing components (DCA chips) onto the flattened particles and reflowing the joints.

IBM Research Disclosure 27109 describes a tool for placing solid solder balls onto a surface mount device (or chip). The balls are of the order of 0.625 mm diameter. The surface mount device is screen printed with sticky solder paste sites and the device positioned above a template having an arrangement of apertures containing balls positioned to correspond to the sticky solder paste sites. The solder paste which is used to hold the balls in place is only printed onto the contacts. The balls are held in place on the template by gravity with assistance from a vacuum, which is released to allow the surface mount device to extract the balls, which have been retained in contact with the device by the sticky solder paste, from the template. The use of a template with a vacuum also aids the installation of the balls onto the template as the balls are simply spilled over and fall into place on the template.

DCA sites have contacts at a very fine pitch, so it is critical that an exact volume of solder is deposited onto the DCA sites to form a joint. Too little solder will result in an open circuit, whilst too much solder will result in a short circuit. Another problem is that solder pastes cannot be readily printed to such a fine pitch, as clogging of the apertures used for printing results. In addition, paste registration to DCA sites over a whole substrate would be impossible.

A repair of an open circuit or a short circuit contact for this technology is difficult so a method that can guarantee accurate deposition volume to minimise repair activity, is desired. Deposition of molten solder requires an inner and outer mask to be accurately aligned to each other, and then the combination aligned to the DCA site. The alignment of the inner and outer masks is both difficult and time consuming with no guarantee that the finished mask will give the required volumes on all DCA sites. Other variable parameters which must be precisely controlled include the thickness of inner

and outer masks used to deposit the molten solder, hole size of the inner mask, stand off height of the outer mask and the air pressure which forces molten solder through the masks.

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Disclosure of the Invention

The invention provides a method of depositing solder from a reservoir onto metallised contacts arranged on a surface via a pick up head comprising applying flux to the contacts, picking up solder in the form of particles from the reservoir with the pick up head, the head having apertures corresponding to the arrangement of the contacts, positioning the head adjacent the contacts, aligning the apertures with the contacts, and releasing the particles onto the surface, the particles being retained on the surface by the flux.

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Preferably, the method further comprises, after releasing the particles, reflowing the solder particles, levelling the reflowed particles with a flattening head to form reliefs, applying flux to the reliefs; placing integrated circuit contacts onto the reliefs, and reflowing the reliefs to attach the chip to the surface. The pickup head preferably picks up and releases the solder particles by applying and releasing a vacuum. The solder particles are preferably maintained in a fluidised form while being held in the reservoir. This prevents the solder particles sticking together.

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In a preferred embodiment of the present invention, there is provided an apparatus for depositing solder from a reservoir onto metallised contacts on a surface comprising means for supplying a surface, the surface having a plurality of contacts arranged thereon, to the apparatus, a reservoir for containing solder particles, the particle size corresponding to the size of the contacts, means for producing a vacuum, a pick up head having a connection for the vacuum producing means and a plurality of apertures smaller in size than the solder particles and having an aperture configuration corresponding to the arrangement of the plurality of contacts, the head being capable of being positioned in a first position adjacent the reservoir and a second position adjacent the surface, means for dispensing flux onto the contacts, control means for causing the head to transport the particles from the reservoir to the surface, means for aligning the apertures with the contacts and means for controlling the vacuum to the pick up head.

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Preferably, the apparatus further comprises a rotating turret with the heads positioned circumferentially. The turret has an indexing system and is computer controlled.

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Brief Description of the Drawings

Preferred embodiments of the invention will now be described, by way of example only, with reference to the accompanying drawings, with like components in different figures being referenced by like reference numerals, in which:

Figure 1 is an overall view of an embodiment of the invention;

Figure 2 is a cross-section view of a pickup head and a solder reservoir used in the apparatus of figure 1;

Figure 3 is a diagram of the head of figure 2 with solder particles held by vacuum positioned over a substrate;

Figure 4 is a diagram of the head of figure 3 after release of the vacuum;

Figure 5 is a diagram of the reflowing of the solder particles;

Figure 6 is a diagram of another embodiment of the invention including an indexing turret.

Detailed Description of the Invention

The manufacture of solder particles of the required size (approximately 0.125 mm) to a tight tolerance (+/- 0.0125 mm) is well known. The present invention uses particles of this size in place of the molten solder used in prior art solder depositing systems.

Figure 1 shows an overall view of an embodiment of the invention, the apparatus being indicated by reference numeral 100. The apparatus comprises an indexing turret head 600 containing various heads (described later with reference to figure 6) including a vacuum pickup head (211 in figure 2), a component bank 111 containing DCA chips 115, a programmable cartesian coordinate gantry 113 for positioning the heads contained within the indexing turret head 600 in position over a substrate 301. It also comprises two vision systems, the first 110 being used for alignment of the DCA site on the substrate 301, the second 114 being used for positioning and alignment of the pickup head and the DCA chip site. The substrate is positioned under the vision system 110 using a programmable "XY" table 112.

Figure 2 shows a vacuum pickup head 211 having at a first end 213, a template having apertures. These apertures have a footprint corresponding to the footprint of a DCA chip site on a substrate. A second end 212 of the head has a tube 214 which connects via a control means 215 to a vacuum pump (not shown). There is also a reservoir 201 of solder particles 220 in the form of a fluidised bed 202. A fluidised bed is used because the solder particles 220 being very small tend to stick together. The means for achieving a

5 fluidised bed 202 of solder particles 220 are similar to that used for many other types of small particles and so will not be described further. The pickup head 211 initially has no suction applied via control means 215 and tube 214 from the vacuum pump. The pickup head 211 is lowered into the reservoir 201 and the suction from the vacuum pump applied via the control means 215 and tube 214. Air flows into the pickup head 211 through the apertures in the first end 213 and solder particles 220 are attracted from the reservoir 201 to engage with holes in the template at the first end 213 of the head 211.

10 Figure 3 shows the particles 220 held in position against the first end 213 of the head 211 by the vacuum which continues to be applied. The pickup head 211 now transports the solder spheres 220 to the substrate 301 where a machine vision system (110) is used to align the hole pattern in the template with the metallised contacts 302 on the DCA chip site. As described earlier the metallised contacts 302, together with the rest of the substrate were sprayed with a layer of flux 303. For clarity the sticky flux has been shown only on the contacts of the DCA site. Also described earlier, these holes have a pattern corresponding to the footprint of the DCA chip site. Figure 3 shows the pickup head 211 after the holes in the template have been aligned with the footprint of the DCA chip site. The pickup head 211 is then positioned so that it is spaced approximately 0.075 mm from the surface of the substrate 301.

15 Figure 4 shows the vacuum released so that the particles 220 fall under the influence of gravity onto contacts 302 of the DCA chip sites. The particles 220 are retained on the chip sites by the sticky flux 303 sprayed earlier onto the whole of the DCA site.

20 The pickup head 211 is now removed from its position near to the DCA site and a reflow head 511, such as that shown in Figure 5, containing a heat source 512 is positioned over the site. Heat is applied from the reflow head to the solder particles. The reflow head is moved away from the site and a flattening head (not shown) is then positioned above the DCA site and used to level the molten solder particles 501 into reliefs in the form of flattened bumps.

25 An aerosol fluxing head such as the one used earlier is now positioned over the DCA site and flux is again sprayed over the whole of a single DCA site from the aerosol head.

30 A placement head picks up a chip from a component bank and transports the chip from the component bank to a position above the DCA site. The chip contacts are then aligned with the flattened reliefs located on the footprint of the DCA site and the chip placed onto the DCA site. The

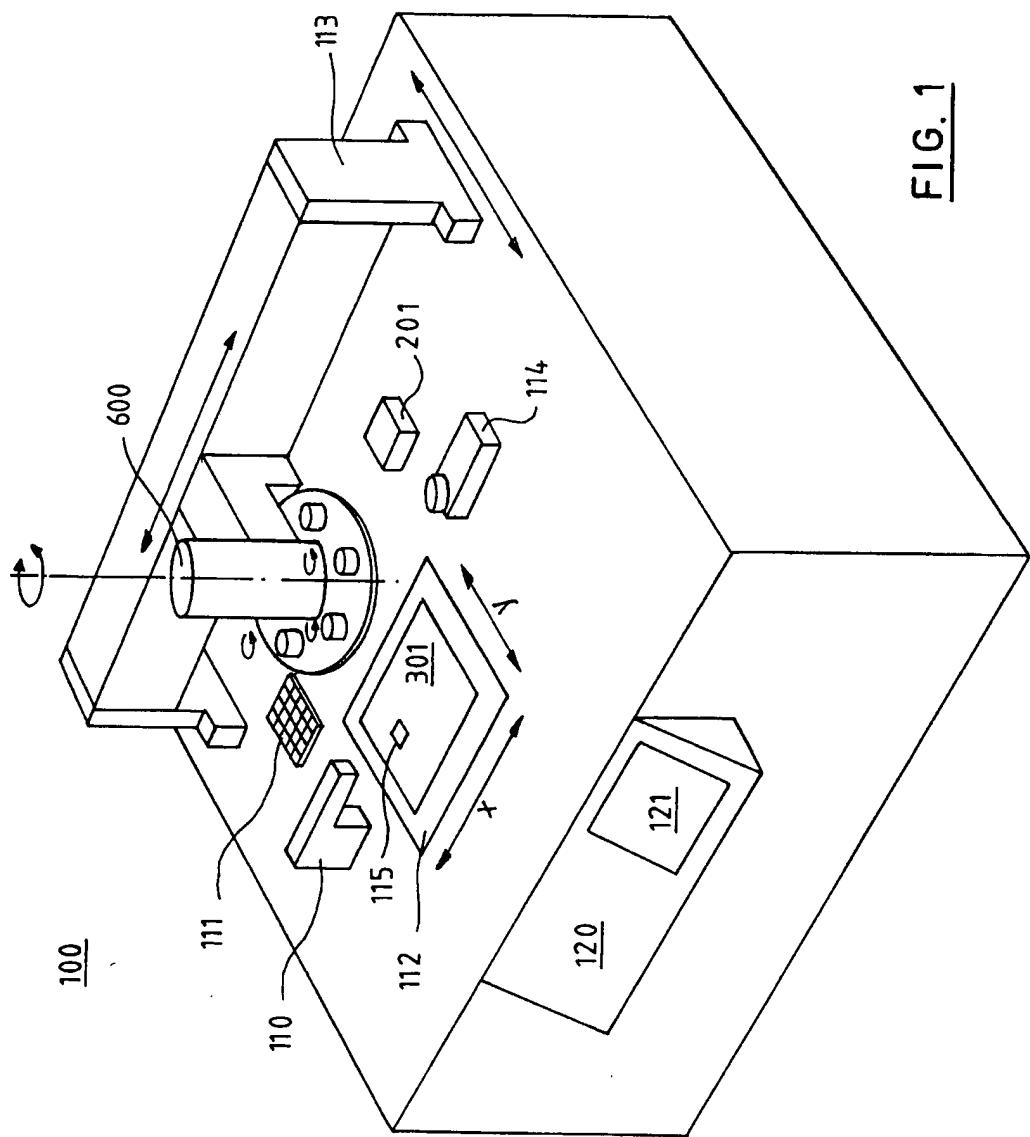
chip is retained in place by the sticky flux sprayed earlier over the whole of the DCA site. A reflow head 511 such as the one used earlier is now used to reflow the flattened reliefs and attach the chip to the metallised contacts 302 on the substrate 301.

Figure 6 shows an indexing turret head 600 used in a further embodiment of the invention. The indexing head contains an aerosol fluxing head 613, a vacuum pickup head 211, a reflow head 511, a flattening head 611 and a placement head 612.

An enhancement to the embodiments described includes the use of positive pressure applied to the pickup head 211 to assist ejection of the solder particles 220 onto the DCA chip site contacts.

Claims

1. A method of depositing solder from a reservoir 201 onto metallised contacts 302 arranged on a surface 301 via a pick up head 211 comprising:
 - applying flux to the surface 301;
 - picking up solder in the form of particles 220 from the reservoir 201 with the pick up head 211, the head having apertures corresponding to the arrangement of the contacts 302;
 - positioning the head 211 adjacent the contacts 302;
 - aligning the apertures with the contacts 302; and
 - releasing the particles 220 onto the surface 301, the particles being retained on the surface 301 by the flux.
2. A method as claimed in claim 1 further comprising after releasing the particles 220:
 - reflowing the solder particles 220;
 - levelling the reflowed particles 220 with a flattening head to form reliefs 501;
 - applying flux to the surface 301;
 - placing integrated circuit connections onto the reliefs 501; and
 - reflowing the reliefs 501 to attach the integrated circuit to the surface 301.
3. A method as claimed in any preceding claim wherein the head 211 picks up and releases the solder particles 220 by applying and releasing a vacuum.
4. A method as claimed in any preceding claim wherein the solder particles 220 in the reservoir 201 are maintained in a fluidised form.
5. An apparatus for depositing solder from a reservoir 201 onto metallised contacts 302 on a surface 301 comprising:
 - means for supplying a surface 301, the surface 301 having a plurality of contacts 302 arranged thereon, to the apparatus;
 - a reservoir 201 for containing solder particles 220, the particle size corresponding to the size of the contacts 302;
 - means for producing a vacuum;
 - a pick up head 211 having a connection for the vacuum producing means and a plurality of apertures smaller in size than the solder particles 220 and having an aperture configuration corresponding to the arrangement of the plurality of contacts 302, the head 211 being capable of being positioned in a first position adjacent the reservoir 201 and a second position adjacent the surface 301;
 - means for dispensing flux onto the surface 301;
 - control means for causing the head 211 to transport the particles 220 from the reservoir 201 to the surface 301;
 - means for aligning the apertures with the contacts 302; and
 - means 215 for controlling the vacuum to the pick up head 211.
6. An apparatus as claimed in claim 5 further comprising:
 - a reflow head including a heat source for reflowing the solder particles 220;
 - a flattening head to form the solder particles 220 into reliefs 501;
 - a placement head for placing the integrated circuit connections onto the reliefs 501; and
 - wherein the means for dispensing flux comprises:
 - a source of flux; and
 - a fluxing head for dispensing the flux to the surface 301 and to the solder particles 220.
7. An apparatus as claimed in any one of claims 5 to 6 wherein the reservoir 201 includes means for maintaining the solder particles 220 in a fluidised form.
8. An apparatus as claimed in any one of claims 6 to 7 further comprising a rotating turret 600 with heads positioned circumferentially.



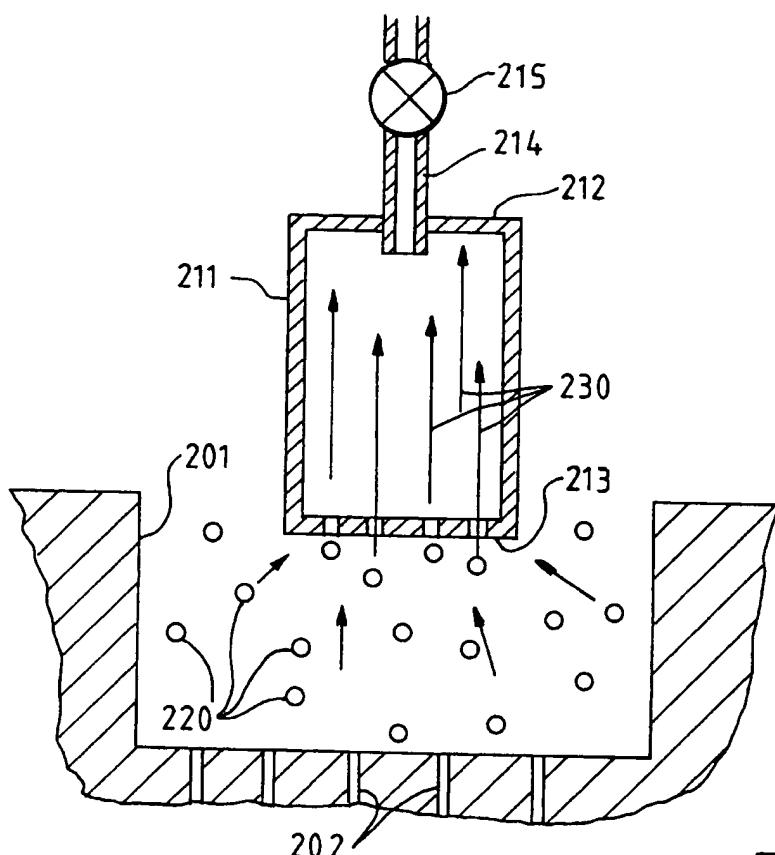


FIG. 2

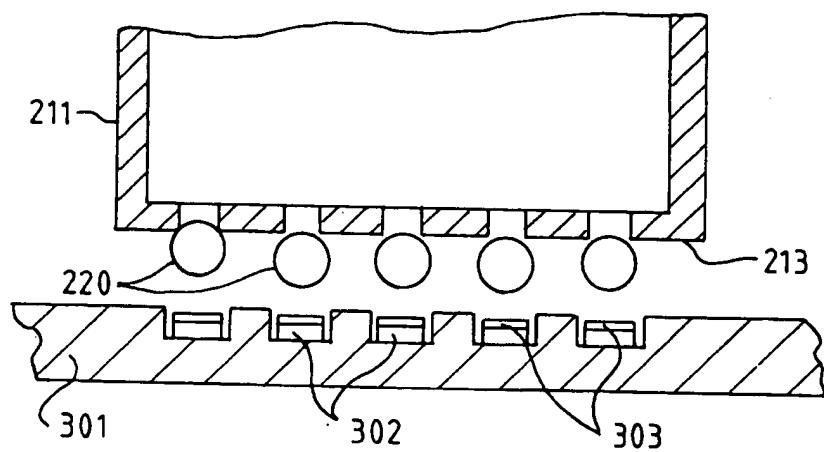


FIG. 3

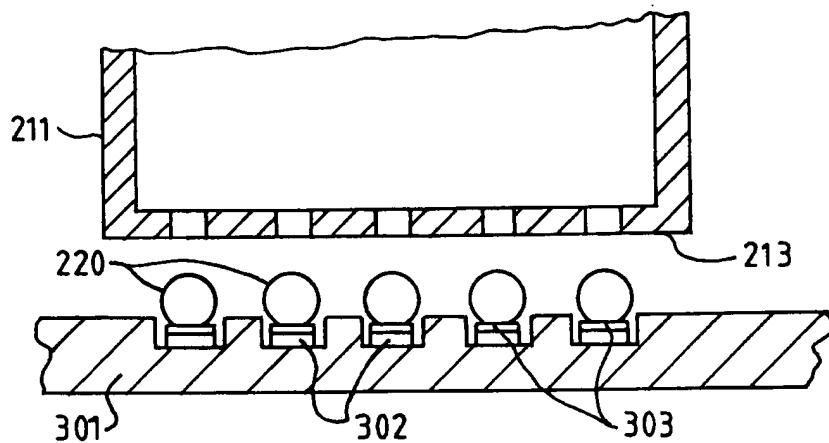


FIG. 4

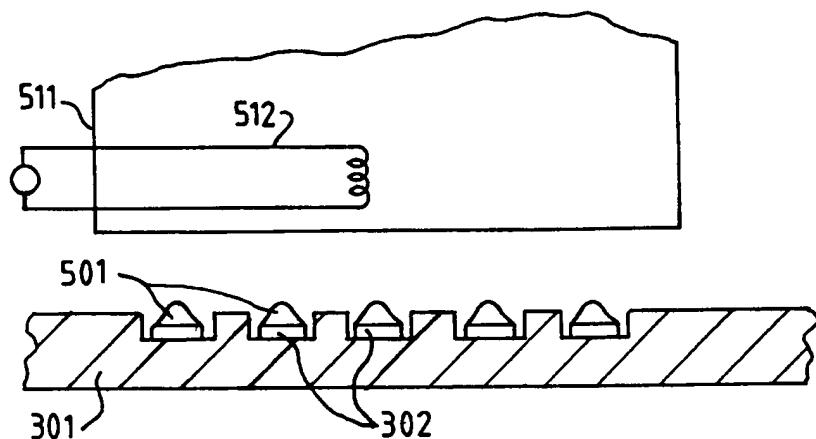


FIG. 5

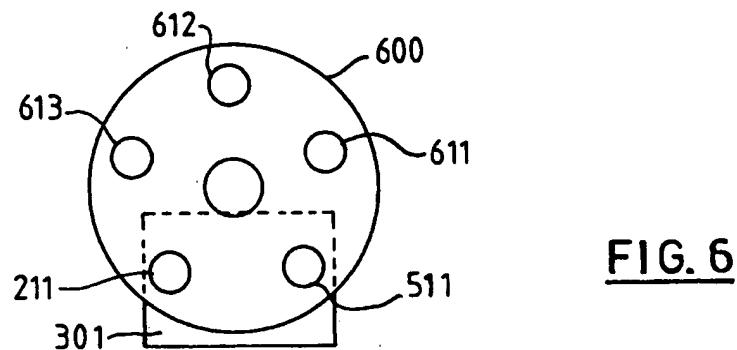


FIG. 6



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EUROPEAN SEARCH REPORT

Application Number
EP 93 30 4702

DOCUMENTS CONSIDERED TO BE RELEVANT			CLASSIFICATION OF THE APPLICATION (Int.Cl.)
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	
X	EP-A-0 263 221 (IBM) * the whole document *	1-5, 7	H01L21/60 H01L21/48
A	---	6, 8	
A	US-A-5 118 027 (BRAUN ET AL.) * the whole document *	6, 8	
A	---	---	
A	EP-A-0 082 902 (IBM) * the whole document *	1-8	
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A	IBM TECHNICAL DISCLOSURE BULLETIN. vol. 24, no. 2, July 1981, NEW YORK US pages 1288 - 1289 R.D. MCNUTT ET AL. 'Chip Removal and Chip Site Dressing' * the whole document *	2, 6	
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The present search report has been drawn up for all claims			HO1L
Place of search	Date of completion of the search	Examiner	
THE HAGUE	5 November 1993	PROHASKA, G	
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